U. S. DEPARTMENT OF AGRICULTURE.

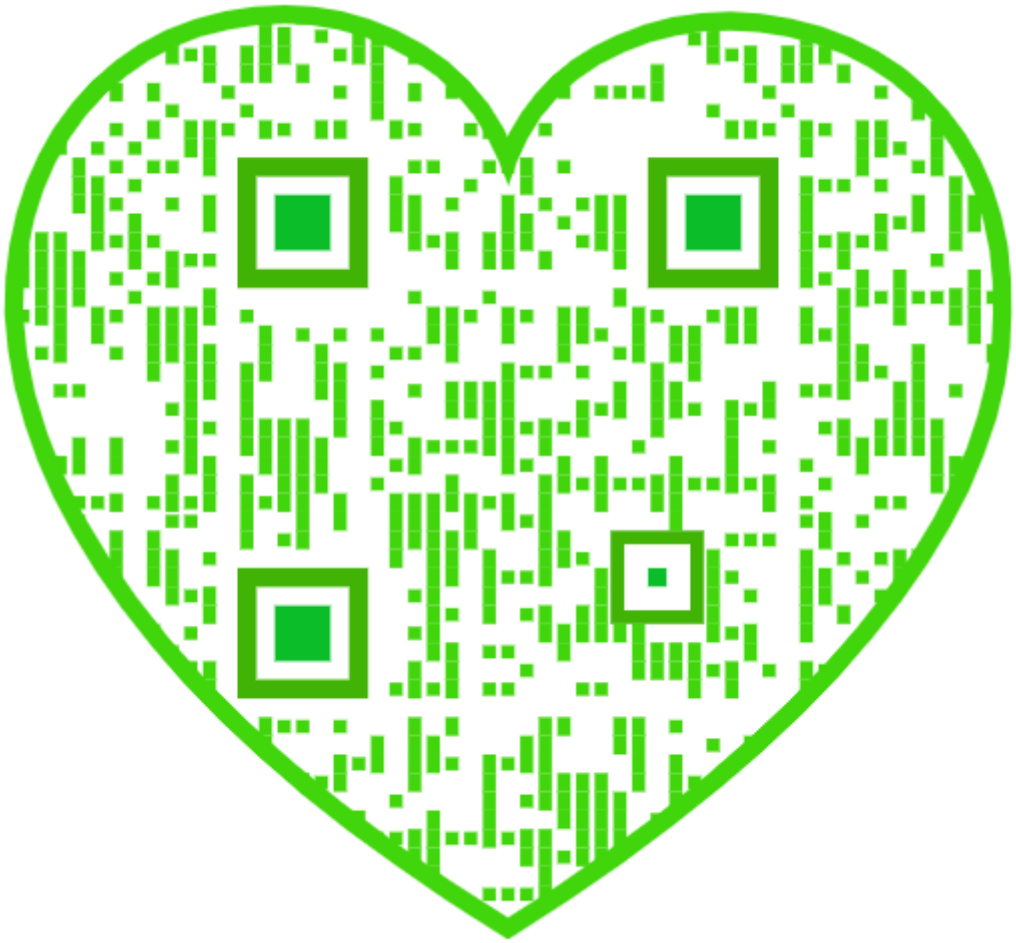
FARMERS' BULLETIN No. 118.

GRAPE GROWING IN THE SOUTH.

S. M. TRACY, M. S.,

Formerly Director of the Mississippi Agricultural Experiment Station.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.



LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF POMOLOGY,
Washington, D. C., April 5, 1900.

SIR: I have the honor to transmit herewith the manuscript of an article on grape culture in the South, prepared at your request by Prof. S. M. Tracy, formerly director of the Mississippi Experiment Station. I have revised the nomenclature, and made such slight changes as were necessary to make it conform to the usage adopted and recommended by the American Pomological Society. As the treatment of the subject is practical in character and popular in style, I respectfully recommend that it be published as a Farmers' Bulletin.

Respectfully,

G. B. BRACKETT,
Pomologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	5
Location and soil	6
The vineyard site	6
The question of soils	6
Propagation	7
Originating new varieties	7
Layering	7
Cuttings	8
Grafting	9
Selection of varieties	11
Origin of varieties	11
Influence of nativity	11
Varieties for the South in general	12
Varieties recommended for Texas	13
Varieties for northern Mississippi, Louisiana, and Alabama	13
Varieties recommended for Georgia	14
Varieties for shipping, for wine, and for table use	14
Planting, cultivating, and fertilizing	15
Laying out a vineyard	15
Preparing the ground	15
Distance apart of vines	16
Planting	16
Cultivation	17
Fertilizing	17
Pruning	17
Definition of terms	18
Objects in view	18
Time of pruning	19
Trellises and systems of training	20
Training to stakes	20
Wire trellises	21
Training on vertical trellis	22
The canopy system	23
The fruit	25
Sacking the bunches	25
Ringing or girdling	25
Gathering and packing	26
Insects and remedies	27
The grape cane-borer	27
The grape leaf-folder	28
The grape-berry moth	29
Fungous diseases and remedies	31
Spraying	31
Bordeaux mixture	31

ILLUSTRATIONS.

		Page.
FIG. 1.	Grape cuttings	8
2.	Vine ready for pruning	18
3.	The canopy system	24
4.	The grape cane-borer (*Amphiceris bicaudatis*)	28
5.	The grape leaf-folder (*Desmia maculalis*)	29
6.	The grape-berry moth (*Eudemis botrana*)	30

GRAPE GROWING IN THE SOUTH.

INTRODUCTION.

Grapevines grow well in all parts of the South, and with reasonable care they never fail to produce abundant crops. The grape may, therefore, be set down as among the most satisfactory fruits grown in this section. Grapes ripen at a season when other fruits are scarce; their acid flavor is specially agreeable in the warm days of July and August, and they can always be sold at a fair price. In the South the vines are never injured by severe freezes, and therefore need no winter protection. Occasionally a late spring frost destroys the early blooms, but never hurts the vine enough to prevent its bearing a fair crop of fruit. Few fruit-bearing plants are less particular about the soil in which they grow, and few will yield so much fruit in proportion to the land they occupy and the labor they require. Wild grapes are abundant in the woods throughout the entire region, and wherever grapes are found growing wild the cultivated vines are sure to succeed. There is no part of the South where grapes of fine quality can not be grown in sufficient quantity for home use, and in many parts they are an exceedingly profitable market crop.

Although grapes will grow luxuriantly and bear heavy crops with very little attention, still they do need some intelligent care, and without it they are sure to prove disappointing. The actual work of caring for the vines is not great, and the methods which should be followed are simple and easily learned. The development of new varieties has made the production of good fruit much more sure than formerly; the introduction of improved forms of trellis has made pruning a very simple operation; and successful methods of preventing loss from insects and fungi are now so well known that grapes should have a prominent place in every garden. In the following pages are given the methods which Southern growers have found most satisfactory, knowledge of which it is hoped may prove useful to those who wish to grow grapes in a small way for family use, or more largely for market or for wine making.

LOCATION AND SOIL.

The vineyard site.—When grapes are to be grown extensively the location for the vineyard should be chosen with care; but when only a supply for home use is wanted, the vines will naturally be planted in some convenient place near the house, and additional labor will be made to compensate for any deficiencies in the soil. Other things being equal, a gentle slope to the south and east is to be preferred for a vineyard because it favors earlier growth in the spring and earlier maturing of the fruit. If practicable, the vineyard should be arranged with the rows of vines running north and south, so that the tops of the vines will shade and protect the main stems and roots from burn and sun scald. The slope of the ground should not be so steep as to cause washing, but should be sufficient to carry off surplus rainfall promptly. Steep hillsides are often recommended as good vineyard sites, and in some parts of the country they are desirable locations; but, with the rainfall as heavy as it is in most parts of the South, such locations require too much labor in terracing and in repairing damages from heavy rains to be profitable. Perfectly flat lands are equally objectionable, because where the soil does not have quick and thorough drainage the vines make an unhealthy growth, and the fruit is poor in quality. When the fruit is to be grown for market the vineyard should be very near the shipping depot, as the expense and delay of hauling even a short distance are items of considerable importance.

The question of soils.—Grapes will grow on any soil which is suited to the growing of peaches. The best soil is one which is fertile, but not excessively rich; which is loose and easily worked, and which is underlaid by an open and porous subsoil. Neither thrifty vines nor heavy crops of fruit can be produced on a sterile soil. On the other hand, if the soil be too rich, containing an excess of humus and nitrogenous material, as is usually the case with creek bottom soils, the vines will make a rank growth, but the fruit will be small, imperfect, sour, and lacking in flavor. The presence of lime in the soil is always beneficial.

The character of the subsoil also is very important. The surface soil is easily changed and modified by cultivating and fertilizing, but the subsoil will remain practically unchanged. As the roots of the vines are easily injured by excessive heat and drought or by standing water, the subsoil should be of such a texture that the roots can penetrate below the reach of intense heat, and still not suffer from too much moisture. When the subsoil is loose and porous it not only permits surplus water to pass down through quickly, but it also assists the water from below in passing back to the surface in times of drought, thus securing to the vine the constant and uniform supply of moisture essential to its healthy growth. Soils underlaid with hardpan, those which are inclined to wash badly, and those which are not naturally well-drained should always be avoided when selecting a location for an extensive vineyard.

PROPAGATION.

Originating new varieties.—Grapevines are propagated by seeds, layers, and cuttings, and by grafting. Propagation from seeds is employed only for the purpose of originating new varieties. Seedling grapevines may differ widely from the parent stock, and from each other, even when the seeds are from a single cluster of grapes; they require a long time to come into bearing; and their fruit is usually inferior to that of some of the established varieties. Nevertheless, it is by the raising of seedlings that all new varieties are originated, and the man who grows a hundred seedling vines feels amply repaid for all his labor and trouble if he finds among them a single one which produces grapes of superior quality.

Although propagating grapevines from seeds is rarely profitable, the work is of intense interest, and it is the only means by which new and better varieties can be secured. As work of this kind belongs to nurserymen and experimenters rather than practical grape growers, a full treatment of the methods is unnecessary here.

Layering.—All varieties may be propagated by layering, and many varieties, especially those like Norton, Cynthiana, Scuppernong, and other hard-wooded sorts of the Aestivalis and Rotundifolia classes can not be easily propagated by any other means. Layering should be done either in early spring or late in the summer, the spring layering being the more economical and making the better plants. For spring layering a trench of 2 or 3 inches in depth is dug, and a cane of the last season's growth is laid into it and fastened in place with a few wooden or wire pegs. When the young shoots from this cane have made a growth of from 6 to 12 inches, the trench should be filled with fine soil, well tramped in, and the shoots tied to stakes to keep them out of the way of cultivation. When treated in this way the canes laid in the trench will usually make both shoots and roots at each of the covered joints, and so make as many new vines as there are shoots. The trenches should be made lengthwise of the rows, so they will be out of of the way, and in digging the young vines should be separated by cutting the canes just beyond the shoot nearest the parent vine.

Layering may be done in midsummer by bending down and covering shoots of the present season's growth, but it is not often possible to secure more than one or two new vines from each shoot. If the layering is done very late in the season, it is safer to cut a tongue on one side of the shoot which is buried, making the tongue an inch or two in length and about one-third the thickness of the shoot, as roots will start more quickly from such a cut surface than where the bark is unbroken. When treated in this manner many varieties will make strong roots by spring, even when the layering is done as late as September or October. Propagation by layering is more sure than by cuttings, and it is often more convenient and satisfactory when only a few

new vines are wanted. It has the further advantage of being practicable in summer when cuttings could not be made to grow.

Plants grown from layers are not so convenient for handling and planting as are those grown from cuttings, but there seems to be no difference in the growth or productiveness of the matured vines.

Cuttings.—When vines can be grown from cuttings, it is the simplest and easiest method of propagation. Cuttings of the Labrusca, Riparia, and some of the softer-wooded Aestivalis classes, root very easily. Cuttings should be made as soon as convenient after the leaves drop in the fall, and should be made from strong and well-ripened wood of the present season's growth. Each cutting should have at least three joints, and should be from 8 to 12 inches in length. The cut at the lower end should be made just below a joint, as in fig. 1, *a*, or the cutting should have a short "heel" of old wood, as in fig. 1, *b*. The latter

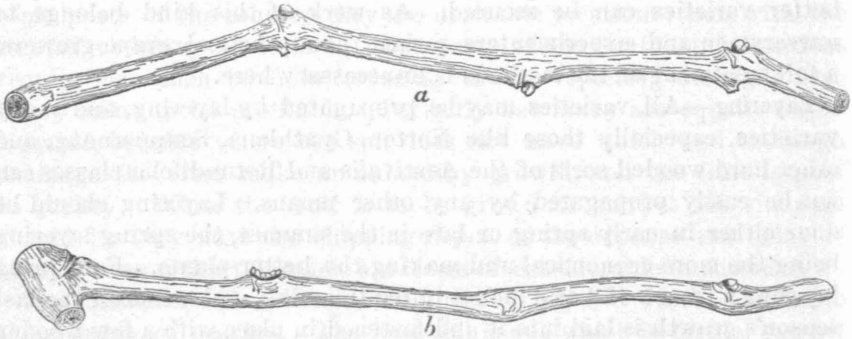


FIG. 1.—Grape cuttings.

form is the better, but of course only one such cutting can be made from each shoot.

The top of the cutting should be an inch or two above the upper joint, and, as a matter of convenience in handling and planting, the cuttings should be of nearly equal length. They may be planted as soon as made, or may be tied in bundles and buried in well-drained soil until spring. The making of cuttings may be deferred until late in winter if necessary, but they are much better if made earlier. When made in the fall or early winter they have time to become well calloused, and so are more sure to form roots and grow promptly as soon as the soil becomes warm in the spring than when made later in the season.

Cuttings should be planted in loose, rich, and light soil as early in the spring as the ground is in condition for working. Dig a V-shaped trench, making one side straight and smooth, and a trifle less than the length of the cuttings in depth. Place the cuttings about 2 inches apart, against the smooth side of the trench, carefully press the lower end of each firmly into the soil, and have the top about even with the surface of the ground. Fill the trench nearly half full with fine soil and then

tramp thoroughly, throwing the whole weight of the body on the heel so as to pack the soil very closely about the lower ends of the cuttings. Then fill the trench full, tramp again, and finish by drawing in loose soil to leave the surface level. As much of the success in growing cuttings depends on having good soil packed very closely about the lower ends, special care should be taken in that part of the planting.

Cuttings may be planted more rapidly and more easily by simply opening the soil to the required depth with a spade, and pushing them down into place and then tramping the soil back against them, but when planted in that manner it is impossible to secure uniformly close contact between the soil and the lower ends of the cuttings, and success is much less sure. When properly made and planted in good soil, at least 90 per cent of the cuttings of such varieties as the Concord and Niagara will grow; but of some other sorts like Norton and Cynthiana, not more than 10 per cent can be expected to make vines. The rows of cuttings should be at least 4 feet apart so as to give ample room for cultivation, and by the end of the season the young vines should have made a growth of from 2 to 8 feet or even more. They will then be ready for planting in the vineyard at any time after the first frost in the fall, or they may remain in the original rows until spring. This is the most common method of propagation, and fully 90 per cent of the vines sold by nurserymen are raised in this way.

Grafting.—Grafting requires more time and is more difficult than either layering or making cuttings, and is practiced only in special cases. Vines which make only a weak growth, or which are subject to disease when on their own roots, often make a more vigorous growth, bear more freely, and are better able to resist disease when grafted onto stocks of stronger and more resistant varieties. Vines of many varieties which can not be grown from cuttings are easily multiplied by grafting. New varieties can be brought into bearing more quickly, and worthless or undesirable sorts can be changed into more valuable and productive plants in a single year. While grafting is not a common or profitable method of propagating vines for sale, the practice is one which may often be used by the fruit grower to his great advantage. The work may be done at any time during the spring, from the time when the buds on the stocks begin to swell until the new shoots are several inches in length, and is more sure to be successful when the sap is flowing somewhat freely than when done earlier in the season. The scions, however, should be cut during the winter and buried in a shaded place where they will remain dormant until wanted for use. Old vines an inch or more in diameter are commonly used as stocks, and the scions are inserted near, or slightly below, the surface of the ground. A grafting chisel, such as can be bought from any seedsman, a fine-toothed saw, a pair of pruning shears, and a sharp knife are the tools which are needed in the work.

A scion should be from 8 to 16 inches in length—the length depend-

ing on the size of the stock—of well-ripened, short-jointed wood of the previous season's growth, and should have three or more buds. The stock should be sawed off at the lowest point which will leave an inch and a half or two inches of straight-grained wood in which to insert the scions, and should then be split down the center by using the broad part of the chisel. When the stocks are more than an inch in diameter it is better to put two scions in each. The lower end of the scion is cut to the shape of a slender wedge as long as the split in the stock, a bud being left at the upper end of the wedge on one side. while the opposite side of the wedge is made slightly thinner. The split in the stock is pried open with the wedge end of the chisel, and the scions are pushed down into place, one on each side, care being taken to make them fit closely. The bud near the lower end of the scion should be on the outside, about even with the top of the stock. Special care should be taken to make the inner bark of scion and stock come together, as it is along the lines of inner bark that the two make the first union, and the success of the work depends largely on bringing them into close contact when the grafts are inserted. The tendency of the split stock to spring back and close up the crack when the chisel wedge is removed, is usually sufficient to hold the scions in place. Grafting wax should not be used, as the stock will have an excess of sap which must be allowed to pass out into the soil or it will become soured and kill the scion. If tying is necessary two or three turns of raffia bark or a narrow strip of cloth will be better than twine, as the latter often cuts into the bark when the wood begins to swell.

When the stocks are small, an inch or less in diameter, it is usually better to insert only one scion, and that may be placed as described above, or in a long, sloping cut made by a heavy knife or the pruning shears in one side of the stock just below where it was cut off. This cut should be made as smooth as possible, and the lower end should reach nearly or quite to the middle of the stock. The inner bark of stock and scion should be joined as evenly as possible. Grafts inserted in this way on small stocks are safer if tied.

When the grafts are in place fine soil should be drawn up around them so as to cover all excepting the upper bud of scion, and packed so firmly that it will not dry out rapidly or be washed down by rain. The graft will be still better protected if a 6-inch flower pot is inverted over the top of the mound. Care must be taken not to bend or loosen the scions in drawing up the soil.

At the time of grafting, a stake should be driven by the side of each stock, and, when the new shoots appear, which may be in a few weeks or not until midsummer, they should be tied so they can not be broken off by the wind. If both scions grow, the weaker one should be cut away and one, two, or three of the strongest shoots from the other (the number depending on the method of training to be followed) should be kept tied to the stake. All other shoots, as well as any sprouts

from the stock below the graft, should be removed as soon as they appear.

When the stocks are strong, and the grafts are made with scions from bearing vines, the new shoots will usually bear a few clusters of fruit the first year, and may be relied upon for a full crop the following season. The work of grafting requires some care and skill, but it affords such a ready means for testing new varieties quickly, and for transforming stocks of inferior sorts into more desirable kinds, that it is often a very profitable operation.

SELECTION OF VARIETIES.

Origin of varieties.—While there are hundreds of named varieties of grapes in cultivation, nearly all of them come from less than a dozen of the twenty or more native species. These native species have been hybridized, crossed, and recrossed, until now a great many cultivated sorts have descended from two or more of the original types. A few varieties, like Herbemont and Norton, are simply wild sorts which have been domesticated; but by far the larger part of our present varieties have been selected from seedlings grown under cultivation. Many of the older varieties, like Concord and Delaware, are accidental seedlings of which we do not know the parentage; but many of the varieties which have come into favor during the last twenty years have been grown from carefully selected seeds from varieties showing specially desirable qualities. Many thousands of seedlings have been grown from grapes, the flowers of which had been fertilized with pollen from other varieties whose good qualities it was desired to combine with those of the fruiting vine, and from these seedlings most of our best varieties have been selected.

Influence of nativity.—As the character of every seedling is determined by the ancestry and environment of the growing seed, it is only reasonable to look for the best varieties for cultivation in any given locality among those springing from seeds which were grown in the same or a similar region. Among the native grapes there are certain species which succeed best in certain localities, some being quite local, while others are found widely distributed. The same vital principle which governs the range of the native species also controls the range of the cultivated sorts, and the best varieties for cultivation in any locality will usually be found among the descendants of those species which grow wild in the same region. Among the valuable hybrid varieties it is rare to find a satisfactory one which is not, in part at least, descended from the wild native species of the locality. The Vinifera varieties, which are the common sorts in Europe and in California, are worthless in the Southern States, and their hybrids, even those having only a small percentage of the foreign stock, usually show great liability to disease. The Labrusca is native to the northeastern part of the United States, and there the varieties of that parentage, like Concord,

Moore *Early*, Catawba, and others are among the best; but farther south, where the wild Labrusca is unknown, they are less desirable. They become less valuable the farther they are removed from their place of origin, and, in the extreme South, they are weak in growth, short-lived, and uneven in ripening their fruit. While many of the varieties which succeed well in the extreme South are derived more or less from Labrusca, nearly all have been derived in part from some of the species native to that region. In the Carolinas and in the mountain region of northern Georgia and Alabama, many of the pure Labrusca varieties do well, but farther south and southwest they are generally unsatisfactory, while those varieties descended from Lincecumii or Bourquiana blood are usually long-lived and prolific. It is such a well-established fact that much of the whole character and usefulness of a variety depends on its ancestry that many nurserymen now give the pedigree of each variety in their catalogues, a practice which is of great assistance to the purchaser in making a selection suited to his particular locality.

Varieties for the South in general.—The species which have been most prolific of varieties suited to the Southern climate and soils are Rotundifolia, Vulpina, Riparia, Bourquiana, and Lincecumii, though a few good sorts have been developed from Cordifolia, Aestivalis, Munsoniana, and others. A few valuable varieties have been produced from hybrids of various species with the Vinifera or European grape, many of them giving fruit of very high quality, but the vines are usually short-lived, and the clusters uneven and unattractive in appearance.

No one variety of grape is suited to all localities, nor does any one variety cover all the needs of any locality. Few varieties are in their prime of fruiting more than ten days or two weeks, while the time between the ripening of the earliest and the latest sorts is more than two months. Every vineyard intended to produce fruit for home use should contain early, medium, and late ripening varieties even when it consists of only three vines. When a dozen or more vines are planted the selection of varieties should be such as will not only give a succession in ripening, but fruit of different flavors and qualities at each successive period. It requires no more room, labor, or expense to plant and care for a vineyard which will yield fruit constantly during two months than for one which matures all its fruit within two weeks. Those who plant for shipping to a distant market or for making wine will usually find it better to grow only one or two varieties, but for a local market and for home use the larger the assortment of good varieties the better.

The number of good varieties is now so large and the characteristics of the different kinds are so varied that it is not difficult to secure sorts which will be healthfu', vigorous, and prolific on every fertile soil, though, as already stated, the choice of varieties should be governed by locality, soil, and the use to be made of the fruit. The black waxy soils of Texas, the sandy coast soils of Mississippi and Alabama,

and the mountain regions of Georgia and the Carolinas need very different assortments to give the best results.

Varieties recommended for Texas.—Professor Munson, who has done more than any other man in the production of new and valuable varieties and for the development of intelligent grape culture, recommends the following for general cultivation in Texas:

	EARLY.	MEDIUM.	LATE.
BLACK.	Champion.	McPike.	Lenoir.
	Early Ohio.	Campbell *Early*.	Kiowa.
	Moore *Early*.	R. W. Munson.	
	Manito.	Ives.	
	Nectar.	Beacon.	
		Concord.	
		Jaeger.	
		America.	
		Carman.	
RED.	Presly.	Brilliant.	Herbemont.
	Dracut Amber.	Brighton.	Muench.
	Wyoming.	Delaware.	Fern.
	Perkins.	Dr. Collier.	Laussel.
		Delago.	Marguerite.
		Catawba.	
		Jefferson.	
WHITE OR YELLOW.	Winchell (*Green Mountain*).	Waupanuka.	
	Diamond.	Niagara.	
		Rommel.	
		Gold Coin.	
		Triumph.	

He also recommends Lukfata, Champanel, Oktaha, and Elvicand as being especially adapted to black waxy, adobe, and chalky soils, having as their foundation the native Mustang and the Champini of the chalk hills of southwestern Texas.

Varieties recommended for northern Mississippi, Louisiana, and Alabama.—On the clay soils found over most of the upland region of northern Louisiana, Mississippi, and Alabama the varieties named in the following list are generally very satisfactory:

	EARLY.	MEDIUM.	LATE.
BLACK	Moore *Early*.	Beacon.	Jaeger.
	McPike.	Concord.	Big Extra.
	Champion.	Carman.	Mrs. Munson.
		Worden.	
		Ives.	
RED	Presly.	Brilliant.	Jefferson.
	Wyoming.	Delaware.	Herbemont.
	Perkins.	Brighton.	Fern.
		Lindley.	Laussell.
WHITE OR YELLOW.	Winchell (*Green Mountain*).	Niagara.	Triumph.
	Diamond.	Empire *State*.	
		Rommel.	
		Gold Coin.	

Varieties recommended for Georgia.—The State Horticultural Society of Georgia, in its report for 1899, recommends the following for general cultivation in that State:

	EARLY.	MEDIUM.	LATE.
BLACK	Hartford.	Concord.	Norton.
	Moore *Early*.	Ives.	Herbemont.
		Worden.	
		Lenoir.	
		Clinton.	
		Merrimac.	
		Wilder.	
		Welcome.	
RED	Delaware.	Catawba.	
	Perkins.	Diana.	
		Berckmans.	
		Lindley.	
		Salem.	
WHITE OR YELLOW.	Diamond.	Niagara.	Goethe.
	Duchess.	Elvira.	
		Missouri Riesling.	
		Noah.	
		Washington, *Lady*.	
		Triumph.	
		Wylie.	

For the mountain region of Georgia, Brighton, Concord, Delaware, Ives, Niagara, and Norton are specially recommended.

Varieties for shipping, for wine, and for table use.—The better varieties for shipping, as given by the same report, in order of maturity, are Diamond, Moore *Early*, Brighton, Ives, Delaware, Niagara, Concord, Perkins, and Diana.

Varieties recommended for wine are Norton, Lenoir, Clinton, Concord, Ives, Thomas, Missouri Riesling, Catawba, Delaware, Elvira, Warren, and Noah.

The Georgia Experiment Station, in its Bulletin No. 28, recommends the following varieties, enumerated in the order of their ripening:

For shipping: Moore *Early*, Delaware, Ives, Niagara, Concord, and Carman.

For table or local market: All the varieties named above, with the addition of Presly, Winchell (*Green Mountain*), Bell, Brighton, Brilliant, Empire *State*, and Goethe.

For wine: Goethe, Missouri Riesling, Elvira, Catawba, Herbemont, Delaware, Scuppernong, Norton, Cynthiana, Cunningham, Ives, Concord, and Thomas.

Varieties of the Scuppernong family, including Thomas, Flowers, Tenderpulp, and others, should be planted in every vineyard south of latitude 35°, and are specially valuable along the Gulf coast from Texas

to Florida. The vines grow with very little care, and the fruit ripens very late after most other varieties have disappeared.

The foregoing lists are suggestive only; they fall far short of including all the varieties which are of value in any of the regions named. While the varieties given are very uniformly successful in the sections for which they are recommended, each section has many localities in which many other sorts are equally valuable. The intending planter should always examine the vineyards of his own immediate neighborhood before purchasing his vines, as the information gained in that way will often be advantageous in enabling him not only to decide what varieties to plant, but also to avoid varieties which are not likely to be satisfactory. If for any reason the planter can not be reasonably sure what varieties will probably succeed in his locality, he may very safely trust the selection to the nearest reliable nurseryman. The man who only wishes to be sure of having a supply of good fruit will do well to plant only varieties of established merit. The growing of new varieties from seed, and the testing of the scores of new sorts which are introduced each year, may well be left to the experiment stations and to such professional fruit growers as have time and money for work of which the results are so uncertain.

PLANTING, CULTIVATING, AND FERTILIZING.

Laying out a vineyard.—In laying out a vineyard the rows should be made to run as nearly north and south as possible if the vines are to be trained on a trellis, but if only stakes are to be used the rows may be run in any direction. By running the trellis north and south all the fruiting parts of the vine have nearly the same exposure to the sun, while the fruit, main stem, and roots are shaded and protected during the hottest part of the day. Protection of the soil from washing is of first importance, however, and the direction of the rows for any method of training should be made to conform to the slope of the ground when the vineyard is on the side of a hill.

Preparing the ground.—In preparing the ground it should be plowed very deeply, as no loosening of the subsoil is possible after the vines are planted. An excellent plan is to plow the ground in "lands" the width of the rows, making the "dead furrows" come where the vines are to be planted, and running the plow through them several times so as to break up the subsoil to a good depth. This thorough loosening of the subsoil is especially necessary where an underlying hardpan prevents good natural drainage. It will be better if all the ground is subsoiled, and if the work is done some weeks or even months in advance of the planting. Just before planting the ground should be plowed again, reversing the "lands," so as to make the ridge come where the furrow was. This should leave at least 2 feet of loosened soil where the vines are planted, and will afford the roots ample room for a free

growth, besides doing much to insure them against suffering from drought.

Distance apart of vines.—The distances between the vines should be somewhat greater than is recommended for northern vineyards, as the longer growing season produces a heavier growth, and it is never profitable to crowd the vines too closely. The rows should be at least 8 feet apart, and the same distance between the vines in the rows is close enough for such moderate growers as Delaware, Elvira, and Gold Coin. Vines of the stronger growing varieties like Concord or Carman should be at least 10 feet apart; 12 feet is none too wide for such rank growers as Fern, Laussel, and Herbemont. Some give the stronger vines as much as 16 feet and find that distance none too great on good soil. Vines of the Scuppernong family should never be crowded, and 8 by 16, or 12 by 12 feet is close enough for them.

Planting.—Only strong, one-year-old vines from cuttings or layers should be used for planting. Two-year-old vines are usually larger and heavier, but do not often grow so well or make as good vines as those planted at one year, while the three and four-year-old vines sometimes sold "for immediate bearing" are of very little value. It is more economical and in every way more profitable to pay a good price for good vines than to use old, stunted, or unhealthy vines which cost nothing.

The holes in which the vines are planted should be of sufficient size to give room for the roots to be spread out in their natural positions, say from 15 to 18 inches in diameter, and deep enough to allow the vines to be set about two inches deeper than they grew in the nursery rows. Very little is gained by making the holes larger than is needed. Where they can be secured, it is very beneficial to put a few pounds of bones in the bottom of each hole and cover them with a little soil before the vines are planted. It is not usually possible to do this for a large vineyard, but where only a few vines are planted to furnish fruit for home use a sufficient supply can commonly be found around a slaughterhouse or in the fields, and they more than repay the trouble of gathering them. No other fertilizer need be used at the time of planting.

The tops of the vines should be cut back to two or three buds. In planting, the holes should be filled with the finest and richest soil. If the surface soil taken from the holes is rich, fine, and mellow, it will be good enough, but if the vines are being planted in a hard clay or a light, sandy soil, it will pay to haul rich woods soil for filling about the roots. The filling should be packed and tramped down firmly, and a slender, 5-foot stake set by the side of each vine, the stakes being kept in the line of the row, so as not to be in the way of cultivation.

All the vines of each variety should be planted together, and, as soon as the planting is completed, or while it is in progress, a complete record should be made, showing the location of all the vines of each variety.

Cultivation.—Grapevines need no special cultivation beyond that necessary to keep them free from weeds, and all the cultivation given should be very shallow in order to avoid injury to the roots. Ordinarily the first working in the spring should be done with a 1-horse turning plow, beginning in the middles and back furrowing, so as to throw the soil away from the vines. The narrow strips left along the rows should be cleaned off with a hoe, fertilizers should be scattered in the open furrows on both sides of each vine, and the ground plowed again, the soil being thrown toward the rows at the second plowing, thus covering the fertilizer. For the later workings there is nothing better than an ordinary 5-toothed cultivator and an occasional hoeing along the line of the row. Cultivation should cease when the growing fruit begins to weight down the vines, but as soon as the crop has been gathered the middles should be run through with a cultivator and the ground seeded with cowpeas or crimson clover, both for their fertilizing effect and for the protection they afford the ground during the winter.

Fertilizing.—The fertilizer should contain a large proportion of potash, with relatively small amounts of phosphoric acid and nitrogen. One of the best fertilizers is hardwood ashes, applied in the spring, at the rate of half a bushel to each vine. When a few bones have been buried under the vines, and such an annual application of ashes is given to supply potash, cowpeas or crimson clover being grown between the rows, the fertilization will be ample to keep the vines in a vigorous and fruitful condition almost indefinitely.

When ashes are not available, any of the potash salts may be used. From half a pound to a pound of muriate or four times that amount of kainit should be given to each vine just before the second plowing in the spring. When bones were not used at the time of planting an annual application of bone meal or of acid phosphate should be given in addition to the potash. Bone meal is usually more satisfactory, and, when acid phosphate is used, it is usually profitable to mix it with about half its weight of cotton-seed meal. Too much cotton-seed meal should not be used, as it will stimulate a too rank growth of unfruitful wood. Where the soil is rich in humus, or where a thrifty fall growth of peas or clover is secured, very little if any nitrogenous fertilizer should be used, but the vines will seldom be injured by excessive application of ashes, potash salts, acid phosphate, or bone meal.

PRUNING.

The training and pruning of grapevines is the most important item in their management, and it is in this part of the work that the greatest number of mistakes occur, although the principles involved are really very simple and easily learned by any one who will give them a little thought and attention.

Definition of terms.—The terms commonly used in speaking of the different parts of a vine are as follows (fig. 2):

A *shoot* is a green or immature growth less than one year old.

A *cane* is a matured shoot.

An *arm* is a cane two or more years of age, and is a permanent part of the vine which is usually fastened to the trellis in a horizontal position, and on which the spurs and branches are produced.

A *branch* is a division of an arm or shoot.

A *spur* is a cane which has been shortened to from 1 to 4 joints; if left longer it is usually called a cane.

The *stem* is the permanent portion of the vine below the arms or canes. Where the stake or renewal system of training is followed the stem

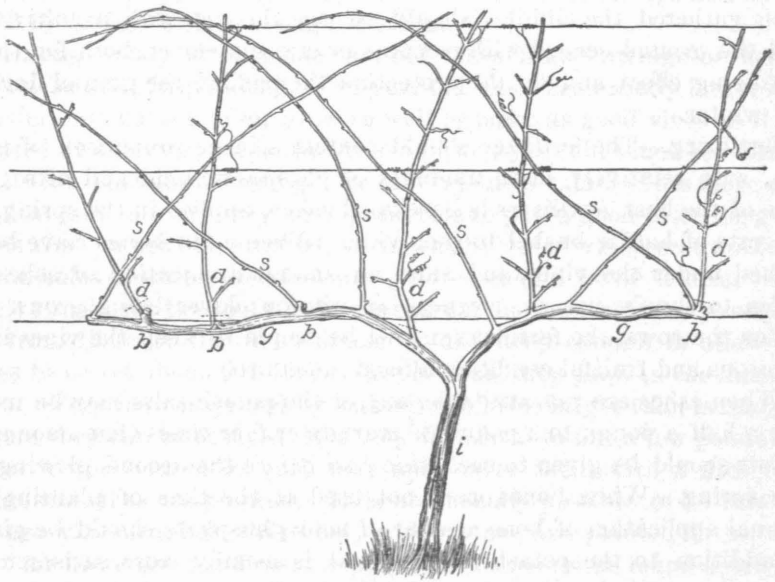


FIG. 2.—Vine ready for pruning; *i*, the stem; *g*, arms; *d*, canes; *s*, shoots; *b*, spurs. The faint lines near the bases of the canes indicate the points where they should be pruned off in the winter, leaving spurs for the production of shoots the following season.

may be only a few inches in length, while in the canopy system of training it reaches to the top of the trellis.

Objects in view.—Most other fruiting plants do better with very little pruning, as the object is to secure the greatest possible amount of fruit from each plant and to make each plant grow as large as possible; but with grapes the object is to secure the greatest possible yield of fruit per square rod or per acre, and not per plant. While a single grapevine bears less fruit when trained to a trellis and kept pruned to a few feet in length than when allowed to grow at will over the tops of trees, the yield of fruit in return for the time, labor, and expense is much greater when the vines are restricted to a convenient size and are

trained in a somewhat unnatural form; hence, in cultivation, extended growth of vine is sacrificed to secure an increased yield of fruit.

The objects to be kept in view in pruning are to keep each vine within its allotted limits and make it assume the form desired, to remove any useless parts and so secure a more vigorous growth of productive wood, and to remove an excess of fruit. It should always be kept in mind that the fruit of the next season will be borne on shoots of this season which were produced on wood grown last season, and that it is usually desirable to remove as much of the old wood as is possible and at the same time to leave as much of the new wood as the vine can support with a thrifty and fruitful growth. As each bud on the spurs will probably produce a new shoot, and as each shoot will ordinarily produce from two to six clusters of fruit, the number of clusters being quite uniform for each variety, the amount of fruit which may be expected from each vine can be estimated quite closely, and the pruning should be done accordingly. When too much bearing wood is left and the amount of fruit produced is excessive, both the clusters and the berries will be smaller, and the vine may be so weakened as to require several years to recover a healthy growth. Too close pruning should also be avoided, as it lessens the opportunity for fruit bearing, and causes an excessive growth of coarse and sappy vine. The after effects of too close pruning are rarely harmful to the vine, and there is far less danger in pruning too closely than in permitting the vine to grow at will or to produce an excessive crop at the expense of its future thrift. The natural tendency of a vine is to make its most vigorous growth from the buds farthest from the roots, and, whatever method of pruning and training may be adopted, the aim should be to confine the growth very near the root or main stem.

Time of pruning.—In winter pruning, ordinary varieties should have from one-half to three-fourths of the entire vine cut away. This work may be done at any time after the leaves drop in the fall, and should be done before the buds begin to swell in the spring. Late pruning is better than no pruning, but permits a great loss of sap which would have been used in the development of new growth if the work had been done at the proper time.

Summer pruning is of great value in giving the vine its desired form, in removing an excess of fruit, in making that which is left larger and of better quality, and in making the next winter pruning simpler, easier, and more satisfactory. This summer pruning should begin by the removal of surplus shoots as soon as the first growth starts in the spring, so that the entire strength of the vine may be used in the directions where it is wanted, and should be repeated two or three times at intervals of a week or ten days. In many vineyards this is the only summer pruning given, but the vines will bear more evenly, produce better fruit, and be longer lived if any excess of fruit clusters is

removed as soon as they appear, and if the fruit-bearing shoots are broken off so as to leave only two or three joints beyond the last cluster of fruit. All summer pruning should be done so early in the season and so promptly that no tools are needed for the work; it should all be done while the new shoots are still so young and tender that they are easily broken off with the thumb and finger. When the wood has become so firm that it will not break easily it may as well remain on the vine until the next winter. Pruning late in summer, or the removal of leaves so that the sun will hasten the ripening of the fruit is never profitable. It costs time and strength for the vine to develop leaves, but when they are once fully grown they become feeders instead of consumers, and every one should be preserved.

As the system of pruning adopted must depend on the style of trellis used, the subject will be treated further in connection with systems of training.

TRELLISES AND SYSTEMS OF TRAINING.

A trellis is needed to give the vines support, and pruning is necessary to secure the most fruitful growth. The best trellis is one which permits all parts of the vine to grow without being crowded; which holds the vine in such a position that all parts can be easily seen and reached for pruning, spraying, and gathering the fruit; which does not interfere too much with cultivation; which allows the fruit to hang in such a position that it is protected from the scorching rays of the sun; and which is inexpensive. Each style of trellis has its advantages as well as its disadvantages; the one to be adopted for any vineyard will depend somewhat upon the varieties of grapes to be grown, and still more on the personal preference of the cultivator.

Training to stakes.—The most simple and inexpensive form of trellis is a stake set at each vine, and as this method of training affords an opportunity for cultivating in both directions it is preferred by many. Weak-growing varieties do well when trained to single stakes, but all strong-growing sorts should have two stakes at each vine to avoid too close crowding of the canes and shoots. The stakes should be 5 or 6 feet in length, 2 or 3 inches in diameter, and of durable wood which will last as long as the vine is likely to live. When inferior wood must be used the stakes should be a foot longer, so that when the lower ends decay they can be reversed and used again.

One stake should be set when the vines are planted. The growth of the first year should be confined to a single cane, which should be kept tied to the stake, and the only pruning needed will be to rub off any additional shoots which may start from near the ground on the old wood. This removal of surplus shoots should be done as often as once in two weeks during the spring, as it is desirable to force all the strength of the vine to go toward making a single, strong cane. Some time during the next winter the vine should be cut back so as to leave

the cane not more than 4 feet in length. From two to four of the side shoots may be left with two or three joints each, and all others should be removed.

The next spring several shoots will start from near the root, the best two of which should be tied to the stake, and all others should be removed as soon as they appear. If two stakes are to be used for each vine the second one should at this time be set on the side of the vine opposite the first, and the new shoots should be tied to the new stake, while the old cane remains on the old stake. The two shoots which are saved should have their tops pinched off as soon as they reach the top of the stake, so as to induce a stronger growth of the side branches. The single cane from the previous season may produce a few clusters of fruit, but should not be allowed to bear so much as to check the vigorous growth of the new shoots. Two or three clusters on each spur will usually be all that the vine should support.

At the end of the second season the old cane should be cut off just above the two new ones, the latter should be cut off a little below the tops of the stakes, and from three to five spurs of two or three joints each should be left on each, and one of them should be tied to each stake. From this time onward the winter pruning and training will be nearly the same each year. Two new shoots should be allowed to grow from as near the ground as they can be secured, and the old canes cut away as near the ground as possible, one of the new shoots and one of the old canes being trained on each stake.

This is the cheapest and simplest trellis which can be devised, but has serious disadvantages in that it crowds the vines and fruit so that both suffer from want of air and light; it does not afford a good opportunity for spraying; the growth is so dense that it is often difficult to see and gather the fruit; and, the soil on the south side of the vines not being shaded, the roots often suffer from heat. This method is much better adapted to the weaker growing sorts, like Delaware, than to stronger varieties, like Niagara, and is wholly unsuited to such rank growing vines as Herbemont.

Wire trellises.—For building a wire trellis the posts should be about 7 feet in length, so that the tops will be at least 5 feet above the surface of the ground. They should always be made of the most durable wood obtainable, as it is very troublesome to replace one which has rotted off, and if one fails during the summer there is sure to be a considerable loss of fruit and injury to the vines. The posts at the ends of the rows should be heavier than the others, and should be set at least 8 feet from the fence, so as to leave room for a horse to turn in cultivating. The end post should be from 4 to 6 feet outside of the first vine, while the second one should be halfway between the first and second vines. These two posts should be double tied by heavy wires or 1 by 6-inch boards running diagonally from the top of each one to the bottom of the other and fastened together where they

cross in the middle. As a good part of the strain from the entire trellis comes on these posts it is important that they should be set firmly and well braced. The other posts should be set at twice the distance between the vines. Galvanized wire, not smaller than No. 12, should be used. Three wires will give much better satisfaction than two, and these may be stapled to the sides of the posts at about 20, 40, and 60 inches from the ground, or may be fastened to crosspieces resting on the tops of the posts.

Training on vertical trellis.—When the wires are fastened to the sides of the posts so as to make a vertical trellis, the training of the vines may be made to follow any one of several methods—the two more common methods being the "fan" and the "horizontal arm" systems. When the fan or renewal system is adopted the pruning should be very similar to that practiced when the vines are trained on stakes. Two or three shoots are grown from near the ground each year, and are tied to the wires in any convenient position, the ends being cut off when the shoots are 4 or 5 feet in length. At the winter pruning all the old canes are cut away just above where the new growth started, and the young canes are shortened to a length of 3 to 5 feet. From three to five of the side branches on the young canes are shortened to spurs of two to four joints, and all the others are removed. The canes are then tied to the wires in a fan-like position, so as to allow each one the greatest amount of room. When trained in this way nearly the whole vine is renewed each year, as is also the case when stakes are used, and there are many varieties which produce much better so than when trained with a long, permanent stem. One of the principal objections to this method is the fact that it is often impossible to secure the desired number of shoots from near the ground. Frequently a vine makes no vigorous shoots excepting well up on the bearing canes 2 or 3 feet from the ground. In such cases the only thing to be done is to save the best shoot nearest the bottom of each cane, and then prune as described above. Ordinarily a variety which persistently fails to produce shoots from near the ground will make a better growth and yield more fruit if trained to form permanent arms.

In the arm system of training, a single shoot is allowed to grow to the height desired; the end is then broken off, and the two upper branches are trained horizontally along one of the wires, all other branches being removed as soon as they appear. Some growers prefer the arms fastened to the bottom wire, so that the future branches can grow erect and be fastened to the upper wires, while others prefer the arms fastened to the upper wire, so that the young branches and fruit will hang downward. The choice between the two methods depends more on the personal preference of the cultivator than on any practical difference in results. In either form the same plan of pruning is followed, though in one the branches are tied upward and in the other downward from the arms.

As fast as the arms grow from the main stem they should be

fastened to the wire on which they are to remain, and be allowed to grow at will the first season. The next winter they should be cut back to somewhat less than half the distance to the next vine and, excepting on very strong vines, all the side branches should be removed. In the spring of the second season all sprouts from the main stem below the arms should be rubbed off, and if the growth from the buds near the outer ends of the arms is too rank a part of it should be cut back to encourage a stronger growth from the buds near the fork. Each joint of the arms should produce a branch, and these should be kept tied to the trellis so they will not be broken or twisted by the wind. Weak-growing vines should not be allowed to bear fruit, but on the stronger vines a small amount may be left, and the branches on which this is borne should have their tips removed after they have made five or six leaves. The next winter, and each succeeding winter, from two to five spurs, each having from two to four joints, should be left on each arm, all others being cut back to short stubs. These spurs should be distributed along the arms as evenly as possible, and nearly the same amount of fruit should be left on each. New shoots will usually start from the stubs where former branches were cut close to the arm, and these furnish the fruiting wood for the next season.

The canopy system.—What is known as the canopy method of training, which is another form of the horizontal arm system, is now more popular and seems better adapted to the conditions prevailing in the South than does any other. In a trellis for this method the posts are set as for a vertical trellis, and the tops are sawed off so as to make them of a uniform height, about 5 feet. Strong 2 by 4-inch crosspieces (heart pine is good) at least 26 inches long are nailed on the tops of the posts at right angles to the direction of the row. On top of these, the wires are strung along, being stapled to each crosspiece, one in the middle and the other two an inch from the ends, so that the three wires form a horizontal trellis 2 feet in width. In the "Munson" trellis the middle wire is placed about 6 inches lower than the two outside wires, and so the vine is given a trough-shaped support. For this style the better way to put the middle wire in place is to pass it through holes bored 4 inches below the tops of the posts, but it is often stapled to one side of the post. In some vineyards where this trellis is used two slender posts, set in the same hole and with their tops diverging 2 feet, are used in the place of single posts and crosspieces. The posts are fastened together by a heavy wire 6 inches below their tops. The middle wire of the trellis rests on this, while the side wires are stapled directly to the ends of the posts. Good single posts and crosspieces are to be preferred whenever they can be obtained at a reasonable cost. This form of trellis supports the growing shoots, so that they are seldom broken off by wind, and its form makes summer tying almost unnecessary, but is not quite so convenient in spraying as is the horizontal form.

When vines are trained by this system, the growth of the first season

is confined to a single shoot, which is kept tied to a stake until it has nearly reached the middle wire, when the tip is removed and the two upper buds are allowed to develop branches, which are tied in opposite directions along the wire to form the future arms. Strong plants on good soil which is well cultivated will make this amount of growth the first season, but weaker plants on poorer soils may require two seasons to develop the arms to their full length. The first winter these horizontal arms are shortened into a little less than half the distance to the next vine, and the following summer a few bunches of fruit may be allowed to grow on each. The second winter from two to four spurs of two to four joints each should be left on each arm, all the other canes being cut off close to the arms, and a full crop of fruit should be produced the following season. From this time onward the pruning should be much the same each year, the spurs which have borne fruit

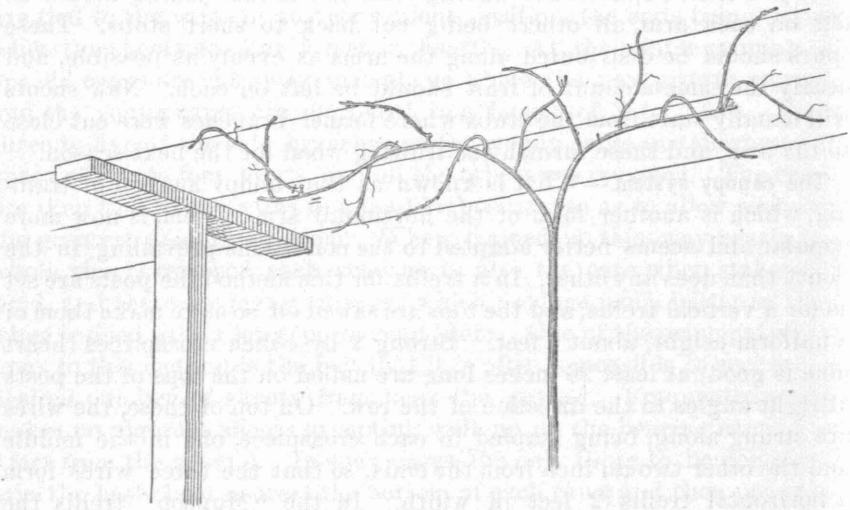


FIG. 3.—The canopy system.

being removed each winter and replaced by new spurs coming from the permanent arms. Some of the stronger-growing varieties may be allowed to make two permanent arms on each side, while with other varieties it will occasionally be found necessary to replace the arms with new canes grown from near the top of the stem.

In fig. 3 is shown a vine trained by this method, the small cross marks near the bases of the fruiting canes indicating the points where they should be cut in pruning.

While this trellis is slightly more expensive than the vertical form, those who have used it consider it far superior. It permits the vine to grow nearly in its natural form, and distributes the branches over the allotted space very evenly with but little attention to summer tying; the bunches of fruit are shaded and protected by a canopy of leaves, and so suffer much less from disease and sunscald; the main stem and roots are shaded from the noonday sun; all parts of the vine are

in the best position for spraying; and the cultivator can go from one part of the vineyard to another without being obliged to go around the ends of the rows, or to lose buttons and good temper in crawling between the wires.

While it is easy to give directions for making a trellis, it is impossible to give definite rules for pruning which can be followed in all cases and with every vine. No two vines are exactly alike, and the pruning must be varied accordingly. Strong-growing and vigorous varieties like Niagara and Herbemont should not be pruned so closely as weaker-growing sorts like Delaware and Gold Coin, but in general, especially in small vineyards, a thousand vines are pruned too little for every one which is pruned too much. The one important point to be kept in view in all pruning is to secure the greatest possible amount of bearing wood in the smallest possible space, and at the same time to secure a sufficient growth of new wood to replace it the following season. Vines of the Scuppernong family should always be grown on arbors, and the only pruning needed is to confine the growth of the young vines to a single cane until it reaches the top of the arbor, when it should be allowed to branch and run at will.

THE FRUIT.

Sacking the bunches.—The surest way to secure fine bunches of perfect fruit is to sack each cluster when the grapes are no larger than small shot. For this work the grocer's ordinary paper bags, of the 2 or 3 pound size, are used, and afford very complete protection from attacks of fungi, insects, and birds. The bags should be put on as soon as possible after the fruit is set, and the work can be done very rapidly. The bags should have a small piece cut off from one of the lower corners, so that they will not hold water after heavy rains, and they should not be larger than are needed or many will be torn off by wind. In putting them on, the mouth of the sack is opened by grasping it by the longer edge and giving it a quick jerk; it is then slipped over the bunch of fruit, the mouth is doubled and folded around the stem and fastened in place with a pin. The cost of the work, including bags, pins, and labor, does not exceed one-half cent per pound for the fruit, and so it is often very profitable, especially where there is a demand for fancy fruit at something above the usual market price. Sacking in this way gives complete protection from rot and mildew and so insures perfect bunches. It prevents attacks from wasps and other insects, and preserves the bloom on the fruit so as to make the bunches much more attractive in appearance than when they are exposed to beating winds. The more tender and thin-skinned the fruit the greater will be the benefit secured by the work.

Ringing or girdling.—Ringing or girdling the vines is sometimes practiced to hasten the ripening of the fruit and to increase its size. The operation consists simply in removing an entire ring of bark, from

one-fourth to one-half an inch in width, from around the arm or cane which bears the fruit. It is very quickly done by passing a knife around the vine twice, with sufficient pressure to cut only to the wood, and then taking out the narrow ring of bark between the two cuts. The work should be done early in the season, soon after the fruit sets, and should be practiced with caution, as the part of the vine treated will be of no further use and should be removed at the next pruning. Fastening a wire closely about a branch will produce nearly the same results, and is equally destructive to the vine. The practice has been in use many years, but it is not one which is likely ever to become common. It can be followed to advantage when a few specially fine clusters are wanted early in the season for exhibition purposes, and, as the girdling hastens the ripening of the fruit a week or ten days, it is sometimes profitable when early fruit is grown for market. As girdling kills the branches on which it is done, and the whole vine is often weakened by the unnatural treatment, the practice can be recommended as desirable or profitable only in special cases.

Gathering and packing.—For home use or for making wine, grapes should not be picked until they are fully ripe. Many varieties become highly colored some days, or even weeks, before they are fully matured; but they are not really ripe and in the best condition for use until the stem of the bunch begins to shrivel or soften so that it can be easily bent. Even for market, the fruit should not be gathered until very nearly matured, as it ripens but little after being removed from the vine. The unripe fruit may soften somewhat on its way to market, but does not become sweeter or better flavored, and will retain the excess of acid which disappears when the grapes are ripened on the vines.

Gathering grapes for market should be done only in fair weather when the vines and fruit are not wet with either dew or rain. The stems should be cut with a knife or scissors and the bunches should be laid in shallow wooden trays or baskets for carrying to the packing shed. Baskets holding 5, 8, or 10 pounds, with covers fastened on by wire hooks, are the best packages in which to ship, as they are inexpensive, easily handled in transportation, and convenient and tempting to purchasers. The fruit should be allowed to lie a few hours so that the stems will become slightly wilted; and all diseased, unripe, or bruised berries should be removed before packing begins. The bunches should be placed in the baskets with the stems downward, and packed snugly, the smaller bunches being used to fill the spaces between the larger ones. The top of the fruit should be about half an inch above the top of the basket and should be even and level. The baskets should be so full that some pressure will be needed to bring the cover down into place, though the pressure should not be so great as to crush the grapes or break them from the stems. A basket which is not packed closely will never carry the fruit in good condition; and, as the fruit is sold by weight, close packing is economical. The name of the

variety, as well as the name and address of the grower, should be stencilled on the tops of the covers before they are put in place. Mixed or inferior fruit will seldom pay for shipping and will never add to the good reputation of the grower.

Nearly all of our grapes ripen in July or August while the weather is still warm, and it is difficult to keep them any great length of time without placing them in cold storage, which is expensive. They can be kept a short time by wrapping each bunch in paper and putting them in a cool place. Still better results will be secured by placing a layer of cotton batting in the bottom of a box, then a layer of fruit covered by another layer of batting. Not more than two layers of fruit should be placed in a box, and the upper layer should have a thick covering of cotton. Neither of these methods will be found profitable for market purposes, but will often be desirable when a little fruit is to be kept for some special purpose. There is considerable difference in the keeping qualities of different varieties, and, in general, the late ripening sorts will keep longer after being gathered than will those which ripen early in the season:

INSECTS AND REMEDIES.

The following descriptions and illustrations of the three insects regarded by the writer as most injurious to grapes in the South are taken from The Principal Insect Enemies of the Grape (Farmers' Bulletin No. 70), prepared by C. L. Marlatt, assistant chief, Division of Entomology, United States Department of Agriculture:

THE GRAPE CANE-BORER.

(*Amphicerus bicaudatus* Say.)

The young shoots of the grape during the spring months in some districts will often be observed to suddenly break off or droop and die, and if examination be made a small hole will be found just above the base of the withered shoot, with a burrow leading from it a short distance into the main stem. Within the burrow will be found the culprit in the form of a peculiar cylindrical brown beetle about half an inch long. This beetle has long been known as the apple twig-borer, from its habit of boring into the smaller branches of the apple in the manner described for the grape. It also sometimes similarly attacks pear, peach, plum, forest, and shade trees, and ornamental shrubs. To the grape, however, it is especially destructive, and the name "grape cane-borer" is now given to it as more appropriate. Much complaint of this beetle is always received during the winter and early spring. Frequently all the new growth is killed, and in some cases vines have been entirely destroyed. It is extremely common in the States bordering the Mississippi, from Iowa to Arkansas, and also in Texas, often becoming throughout this region the most important insect enemy of the vine. It also occurs eastward to the coast, but rarely causes much damage in its eastern range.

It breeds in dying wood, such as large prunings, diseased canes, and also in dying or drying wood of most shade and fruit trees. It has been found by the writer breeding very abundantly in roots of uprooted maples and in diseased tamarisk stems. In old, dry wood it will not breed, so far as is known, nor in vigorous live growth, but seems to need the dying and partially drying conditions mentioned.

The insect has but one brood yearly. The beetles mature for most part in the fall, and generally remain in their larval burrows until the following spring. A few may leave the burrows in the fall and construct others in the twigs of apple or other plants in which to hibernate. In the spring, however, they begin their destructive work early, burrowing into the axils of the grape and occasionally also into other plants. This is undoubtedly partly for food, but seems largely malicious, for it certainly has nothing to do with egg laying, although it may have some connection with the marital relation. The eggs are laid chiefly in May, or as early as March or April in its southern range, and the larvæ develop during summer, transforming to pupæ and beetles in the fall.

Remedies.—It will be apparent at once that to limit the work of this insect it will be necessary to promptly destroy all wood in which it will breed. This means the

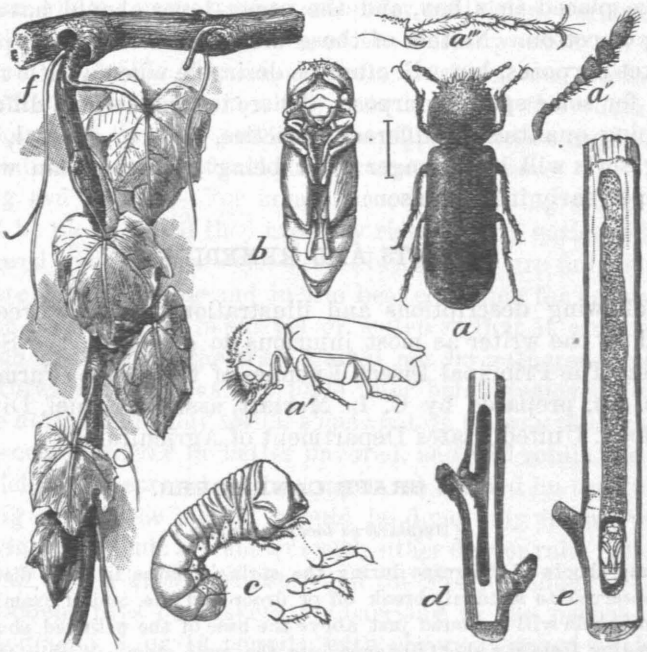


FIG. 4.—The grape cane-borer (*Amphicerus bicaudatus*). *a*, beetle, dorsal and lateral view; *b*, pupa from beneath; *c*, larva from side, with enlargements of the thoracic feet; *d*, burrow in apple twig made by adult; *e*, larval gallery in tamarisk, with pupa in cell at end; *f*, injury to young shoot and cane, showing the entrance to burrow of beetle near *f* and the characteristic wilting of the new growth—all much enlarged except *d*, *e*, and *f*.

careful removal and burning of all diseased wood and prunings at least by midsummer, thus destroying the material in which the larvæ are probably undergoing their development. If precautions of this sort are neglected and the beetle appears in the vineyard in spring, the only recourse is to cut out by hand every affected part and destroy the beetles. On warm days they may sometimes be collected in numbers while running about the vines.

THE GRAPE LEAF-FOLDER.

(*Desmia maculalis* Westw.)

One of the noticeable features of a vineyard, particularly in midsummer and later, is the many folded leaves the interiors of which have been skeletonized. This is especially evident with thick-leafed varieties, the whitish under surface contrasting strongly with the dark green of the upper. If the leaf be unfolded, it will

be found to contain a very active, wriggling, greenish larva, a little less than an inch long, which is apt to spring out of the fold and fall or hang by a thread. The leaf itself will be found to be attached to the folded part by means of numerous little cords of silk. If the larva is full grown, the interior of the leaf will be thoroughly skeletonized, and soiled with accumulated excrements. The fold almost invariably brings the upper sides of the leaf together, the larva feeding, therefore, on what would be the upper surface of the leaf. The larva transforms to a reddish-brown chrysalis usually within a much smaller fold of the edge of the leaf, but sometimes within the larger larval fold. The moth, which, during midsummer, issues in a few days, expands about an inch and is a shining opalescent black, with wings bordered with white and marked with white spots, as in the illustration (fig. 5), a slight variation in maculation being noted between the males and females. The moth is seldom seen, but if the vines be shaken it may be frightened up and observed in quick flight seeking other concealment. There are two, or, in the South, three, broods each summer, the last brood hibernating in the leaves very much as does the grape-berry moth, the pupal cases of which are very similar to those of the leaf-folder. It occurs from New England southward to Florida, and westward at least to the Rocky Mountains, and probably is distributed throughout the vine districts of the United States. It affects all kinds of grapes, showing, perhaps, a little preference for the thick-leafed over the thin-leafed varieties.

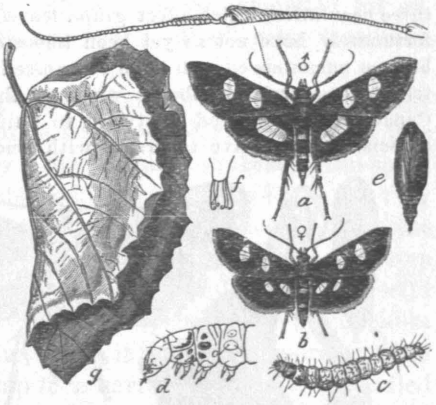


FIG. 5.—The grape leaf-folder (*Desmia maculalis*). *a*, male moth; *b*, female; *c*, larva; *d*, head and thoracic segment of same, enlarged; *e*, pupa; *f*, tip of pupa, enlarged; *g*, grape leaf folded by larva.

Remedies.—The appearance of a leaf folded by a larva of this insect renders its detection easy, and if the vines are gone over and the larvæ crushed in the folded leaves early in the season when they are few in number, allowing none to escape, later damage may be almost entirely prevented. If the vines are sprayed with arsenicals for other leaf-eating insects, the treatment will destroy all larvæ folding leaves soon thereafter, but not those already present. The ease with which this insect may be destroyed by hand makes it hardly advisable to spray for it alone, and after the grapes have become well formed later in the summer it is no longer safe to spray with arsenicals. Aside from hand picking at this time there is nothing to be done except to adopt measures which will afford protection the following year. These consist in the collection and burning of all fallen foliage as promptly as possible in autumn to destroy the hibernating larvæ and chrysalides.

THE GRAPE-BERRY MOTH.

(*Eudemis botrana* Schiff.)

As the grape berries become full grown and begin to ripen, often many of them will be observed to be discolored, and if these be examined a burrow will be found eaten through the pulp from the discolored spot, and within it a whitish larva. These injured berries begin to appear while the fruit is young and green, and as it ripens they increase in number. Frequently several of these discolored and shriveled berries will be fastened together by silken threads intermixed with the excrement of the larvæ and the sticky grape juice, the larva having passed from one to another. The appearance is not unlike that produced by black rot, and is often confused with the latter. As the larva becomes mature it changes to an olive-green

or dark-brown color, and not only excavates the pulp, but burrows into the seeds of the grape. It is very active and is apt to wriggle out of the grape and escape. When full grown the larva attains a length of about one-third of an inch, and, abandoning the grape, cuts out of a grape leaf a little flap, which it folds over and fastens with silk, forming a little oblong case, in which it changes to a chrysalis. The little slate-colored moth with reddish-brown markings on the forewings appears in ten or twelve days, drawing its chrysalis partly after it and depositing eggs for an additional brood of larvæ. The last brood of larvæ remain in the leaf cases through the winter. The moths coming from these hibernating chrysalides appear in early spring, and the first brood of larvæ live on the leaves, tendrils, and blossoms, there being, of course, no grapes for them to infest.

This insect was imported many years ago into this country from southern Europe, where, in Austria and Italy particularly, it is very injurious and has two or three near allies which affect grape leaves and fruit in the same way, but which, fortunately, have not as yet been imported into this country, or if so, have not become numerous enough to be recognized. Our grape-berry moth is widely distributed, occurring probably wherever the grape is grown to any extent, from Canada to Florida and westward to California. It attacks all varieties, but is especially destructive to grapes with tender skins and such as grow in compact

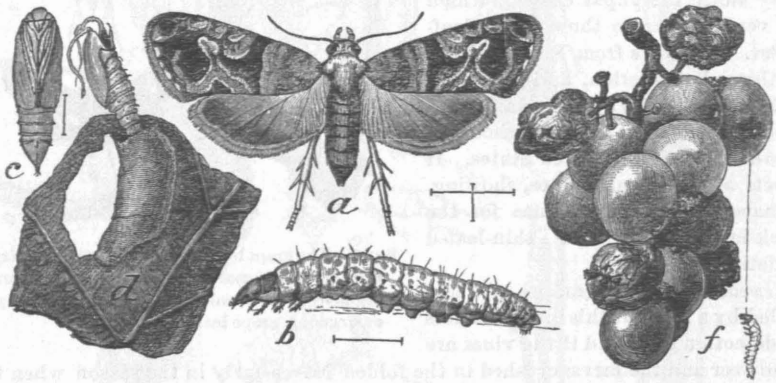


FIG. 6.—The grape-berry moth (*Eudemis botrana*). *a*, moth; *b*, larva; *c*, pupa; *d*, folded leaf with pupa shell projecting from case cut from the leaf; *f*, grapes, showing injury and suspended larva; natural size—all except *f* much enlarged.

bunches. * * * It is probably three-brooded, except in its more northern range, the first brood developing on the leaves in May and June, the second brood on green grapes in July, and the third brood on ripening grapes in August and September. The early brood of this insect is so scanty that it is rarely noticed, and hence protective steps are seldom taken. Later in the season it multiplies with great rapidity, and particularly does it become numerous and destructive if grape gathering be deferred until a late period.

Remedies.—The use of poisons is not practicable except against the first brood, which develops on the green parts of the vine, and here the result is doubtful, because it is more than likely to breed on a great variety of foliage, and spraying would not afford much protection. Bagging the grapes as soon as the fruit sets will undoubtedly protect them from this insect, and at the same time from black rot. Of greater practical value, especially in larger vineyards, is the prompt collection and burning of all fallen leaves in autumn, thus destroying the hibernating larvæ and pupæ, and also the collection and destruction of diseased fruit wherever feasible. Early gathering and shipping or disposal of fruit otherwise is a particularly valuable step, as it insures the removal of the larvæ in the grapes from the vineyard if not their destruction in wine making. All fallen fruit should also be gathered and destroyed.

FUNGOUS DISEASES AND THEIR TREATMENT.

The fungous diseases which affect the grape most seriously are black rot (*Læstadia Bidwellii* Sacc.), anthracnose (*Sphaceloma ampelinum* D By.), bitter rot (*Melanconium fuliginium*), and root rot, caused by the mycelia of several fungi. These have been so fully described in previous bulletins of this series, as well as in bulletins from many of the State experiment stations, that descriptions need not be repeated here. Other diseases are often present, but are rarely so virulent as to cause serious trouble. Nearly all the fungous diseases which affect the vine, leaves, or fruit can be prevented or held in check by spraying with fungicides, and the same general treatment is recommended for all. Thorough and frequent sprayings are the most effective treatment which can be given.

Spraying.—No effective spraying can be done without the use of some kind of a force pump having a nozzle which will divide the spray into a fine mist. Where there are only a few vines to be treated the small syringes such as are used by florists, costing from $1 to $1.50, are very serviceable. For a larger number of vines, twenty-five or more, some one of the many knapsack sprayers with a vermorel nozzle, costing from $9 to $12, will be found much more satisfactory, and also very useful for spraying many other plants, both with fungicides and insecticides. If the vineyard is an acre or more in extent, it will be still more economical to mount a strong force pump in a barrel which can be carried through the vineyard on a cart or a light wagon. Force pumps mounted on handcarts are sometimes used, but are too heavy to be moved about easily when the ground is soft.

The first spraying should be given in early spring, just as the buds are beginning to swell and before they open. This spraying should be made with a solution of copper sulphate or bluestone, using 1 pound of the sulphate to each 10 gallons of water. Other sprayings should follow from ten to fifteen days apart.

Bordeaux mixture.—The fungicide to be used is Bordeaux mixture, a preparation of copper sulphate and lime. This is prepared as follows:[1]

Pour into a 50-gallon barrel 25 gallons of clean water; then weigh out 6 pounds of crushed bluestone, or copper sulphate, and after tying it in a piece of coarse sacking suspend the package just beneath the surface of the water by means of a string tied to a stick laid across the top of the barrel. In another suitable vessel, such as a tub or half barrel, slack 4 pounds of fresh lime. Slack the lime carefully by pouring on small quantities of water at a time, the object being to obtain a smooth, creamy liquid, free from grit. When the lime is slacked add sufficient water to make 25 gallons. As soon as the bluestone is dissolved, which will require an hour or more, pour the lime milk and bluestone solutions together, using a separate barrel for the purpose, and stirring constantly to effect a thorough mixing. It sometimes happens that sufficient lime is not added, and as a result the foliage may be injured. To be certain that the mixture is safe hold a steel knife blade in it for 2 or 3 minutes, and if the polished surface of the blade shows a copper-colored tinge add more lime, but if it stays bright the mixture is safe to use.

[1] Farmers' Bulletin No. 91.

The proportions of copper sulphate and lime are often varied from the amounts given above, especially when the same mixture is to be used on fruit trees. It is not safe to increase the amount of sulphate, but 5 pounds each of sulphate and of lime and 50 gallons of water are often used. As the mixture is most effective when first prepared, a new lot should be made up for each spraying, though the separate solutions may be made in advance. The following method is given in the Twenty-second Report of the Connecticut Experiment Station:

Half a pound of copper sulphate is dissolved in a quart of hot water and poured into a fruit jar of that capacity; half a pound of lime is slacked, diluted with water to make a quart, and placed in another fruit jar. These amounts are easily weighed out, the operation of dissolving and slacking can be done quickly, and in a couple of hours enough half-pound lots of sulphate and of lime can be prepared to make a good many gallons of Bordeaux mixture, and if the jars are tightly closed their contents will keep indefinitely. To make 5 gallons of Bordeaux mixture an ordinary wooden pail holding 2½ gallons and a 40-pound (5-gallon) candy pail, such as can be cheaply bought of any grocer, are needed. Into the latter is poured the contents of one jar of lime, and the pail is then half filled with water. Into the small pail is emptied a jar of copper sulphate solution, and this pail is then filled with water. Finally, by pouring the contents of the small pail quickly into the large pail and stirring well, a perfect Bordeaux mixture is obtained.

Where only small amounts of the mixture are needed for each spraying, it is more convenient to prepare the solutions as directed above than to procure fresh lime and go through the entire operation for each of the four sprayings usually given with this mixture.

No spraying should be done while the grapes are in bloom, and in rainy weather the sprayings should be more frequent than in times of drought, though more than fifteen days should never elapse between them.

As a fresh application of Bordeaux mixture will adhere to the fruit and make it unsightly, the last spraying should be made with a solution of 6 ounces of ammonia carbonate and 1 ounce of copper carbonate in 10 gallons of water.

The entire expense for labor and material for making the six sprayings recommended will not be far from 3 cents per vine, and as that is less than the usual price of 1 pound of fruit the work is always profitable.

If the spraying is begun early in the season, and is always promptly and thoroughly done until the fruit begins to color, the losses from disease will be very light. Sprayed vines will be kept in so much more healthful condition that an increased crop may be expected the following year, while an untreated vine which is weakened by disease will usually become still weaker and less fruitful each year until it dies. It should be understood that the object of spraying is not so much to cure disease as to prevent its appearance, and the most thorough spraying of diseased vines or fruit can do but little good excepting as it prevents a further spread of the trouble. While sacking will save most of the fruit from rot and other diseases, it can not protect the leaves and shoots. Heavy crops of good fruit are possible only on healthy vines, and with many of the choicest varieties such vines can be maintained only by persistent spraying.

○